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THE MORPHOLOGY OF THE SUB-ST. PETER SURFACE OF NORTHEASTERN ILLINOIS

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Introduction

In northeastern Illinois the St. Peter Sandstone unconformably overlies successively older strata from the Prairie du Chien in the south to the Franconia in the north (Figs. 1, 2). Wells in the area penetrate thicknesses of St. Peter Sandstone ranging from about 100 to more than 600 feet. Variations of more than 200 feet occur between closely spaced wells, indicating an irregular sub-St. Peter surface. Most of the sub-St. Peter surface in northeastern Illinois is mantled by a layer of angular chert fragments intermixed with red or green shale and some sandstone. Much of the chert is oölitic and was derived from Prairie du Chien strata. This basal St. Peter ranges in thickness from a few feet to 120 feet.

In northeastern Illinois the thickness of the interval between the top of the Glenwood-St. Peter and the base of the Franconia varies from 1100 feet in the southern part of the area to 250 feet in the northeastern corner of the state (Fig. 1). This northward thinning of 850 feet in 100 miles combines depositional thinning of the Franconia, Trempealeau, and Prairie du Chien strata with erosional thinning that removed several hundreds of feet of dolomite of the Trempealeau and Prairie du Chien strata before St. Peter deposition.

Northward depositional thinning of the Franconia, Trempealeau, and Prairie du Chien indicates that the region to the north of Illinois subsided slowly relative to areas farther south. Following Prairie du Chien deposition, a marked uplift in southern Wisconsin and northern Illinois resulted in erosional truncation of the Prairie du Chien and older strata (Fig. 2). This exposed the sequence of dolomite formations and set the stage for development of karst topography in northern Illinois.

Interpretations of Sub-St. Peter Surface

At least three interpretations of the formation of the sub-St. Peter surface must be considered: normal stream valley erosion; subsurface solution and differential compaction; and karst topography. Probably all three factors have acted to shape the surface, for none of these erosional processes is necessarily exclusive of the other two.

Valley Hypothesis. The abnormally thick sections (over 225 feet) of St. Peter in northern Illinois have in the past generally been considered channel fillings in a stream drainage pattern developed on the sub-St. Peter surface (Fisher, 1925, p. 20; Gries, 1937, p. 12; Meyer, 1946; Dapples, 1955, p. 445). However, there are several objections to this interpretation:

1. In Cook and DuPage Counties, Illinois, the interpretation of abnormally thick sections as valley fill results in mapping valleys that include less than

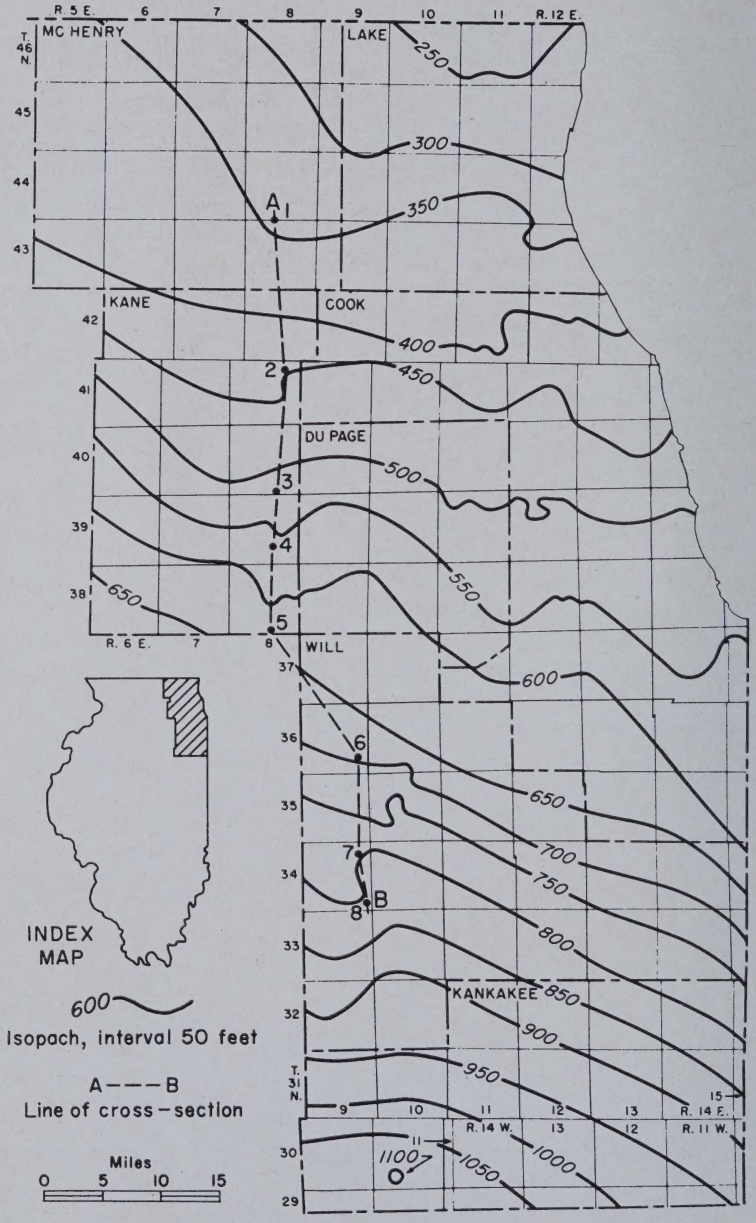

Fig. 1.—Thickness of interval between top of Glenwood-St. Peter and base of Franconia (based on approximately 300 datum points).

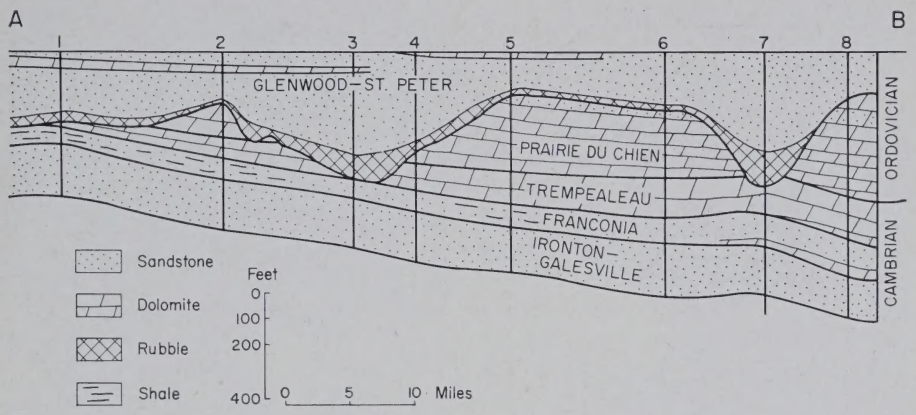

Fig. 2.—Cross section showing relationship of St. Peter Sandstone to underlying strata in northeastern Illinois. Numbers 1 through 8 indicate wells.

one-tenth of the total area, whereas one-third to one-fourth of the deep wells drilled in the area penetrate abnormally thick sections of St. Peter. Assuming random distribution of wells, thick sections of St. Peter should underlie one-fourth rather than one-tenth of the area in those counties.

2. The mantle of angular chert fragments and intermixed shale on the sub-St. Peter surface appears to be a residuum rather than a stream deposit. The widespread occurrence of this residuum indicates that stream drainage was not effective in removing it.
3. Connecting the thick sections of St. Peter into continuous channels requires projecting a winding course through many areas where no data are available in order to avoid areas of thin St. Peter. It seems equally logical to consider many of the areas of thick St. Peter as deposits in sinkholes.

Subsurface Solution and Differential Compaction. Flint (1956, p. 420) concluded that the irregular sub-St. Peter surface of southwestern Wisconsin was developed chiefly by compaction of lime muds over relatively rigid domal structures in the Shakopee Dolomite, the uppermost formation in the Prairie du Chien Group. He also recognized various effects of solution in the Prairie du Chien strata, and suggested that a clayey residuum on the Shakopee was produced by subsurface solution under the load of younger rocks. Flint found no reason to ascribe any of the irregularity of the sub-St. Peter surface in that region to subaerial erosion. These conclusions clearly do not apply to northern Illinois. Extremely thick sections of residuum suggest some transportation of clay and its accumulation in favorable localities. Also, the removal of several hun-

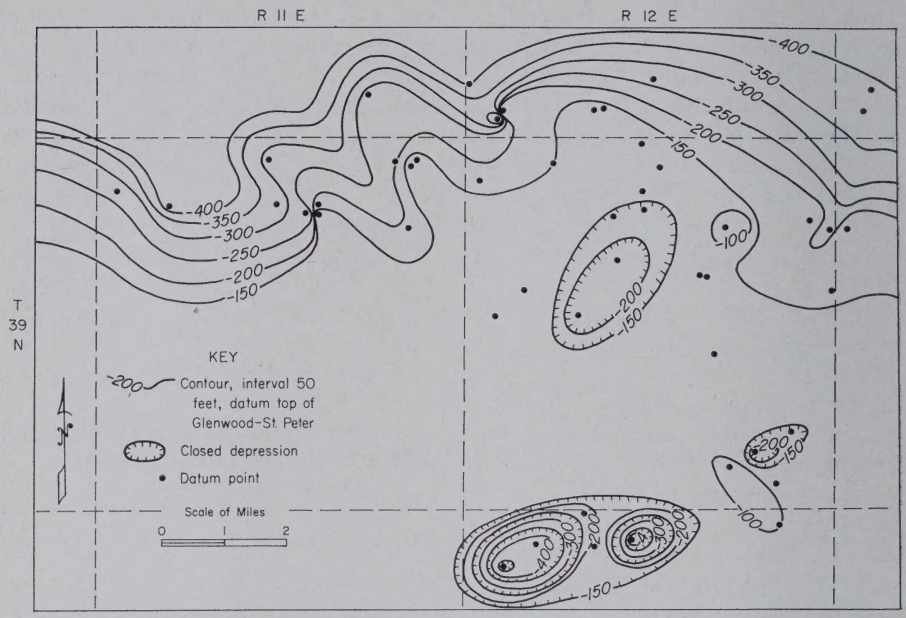

Fig. 3.—Reconstruction of topography of sub-St. Peter surface in northeastern Illinois as shown by thickness of Glenwood-St. Peter.

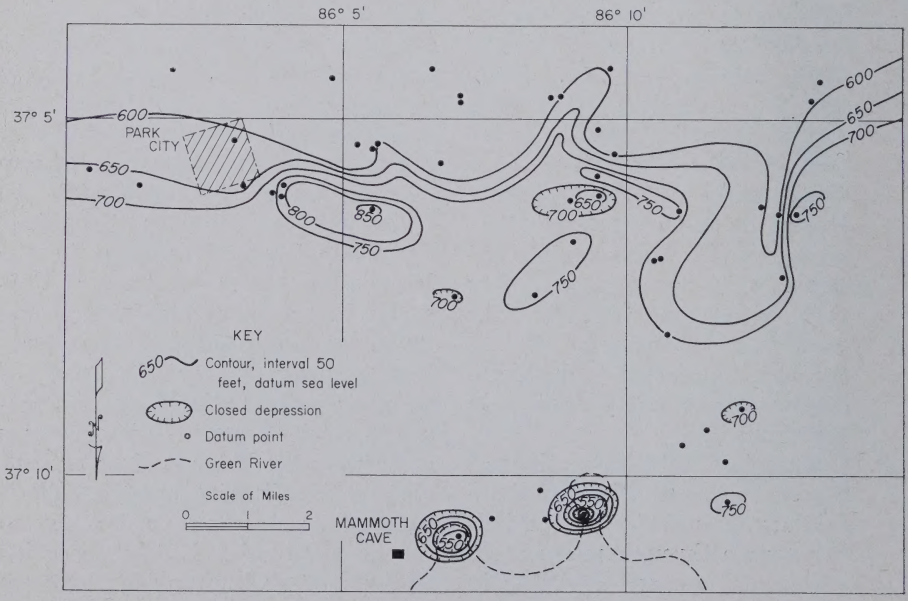

Fig. 4.—Interpretation of topography of Mammoth Cave area (based on distribution of datum points available for reconstruction of sub-St. Peter surface in northeastern Illinois).

dreds of feet of dolomite, and in some places a few feet of Franconia Sandstone, by subsurface solution after the beginning of St. Peter deposition and before final Glenwood deposition seems unlikely. As the top of the Glenwood-St. Peter is essentially flat across the thin and the abnormally thick sections of St. Peter, any solution collapse would have had to be completed before Glenwood deposition ended.

Karst Topography. Prairie du Chien rocks generally underlie the St. Peter south of an east-west line drawn across Illinois 30 to 40 miles from its northern border. North of this line the Prairie du Chien occurs only sporadically, and the St. Peter normally overlies the Trempealeau Dolomite, or, where it too has been removed, the St. Peter rests directly on the Franconia Formation. The east-west line may represent a northward-facing escarpment of a cuesta in which the beds dipped gently southward (Fig. 2, between wells 3 and 5). Behind or south of the escarpment, the locally thick St. Peter Sandstone and basal rubble suggest nearly mature karst topography that had a considerable amount of underground drainage. In front or north of the escarpment, outliers of Prairie du Chien occur as knobs or plateau remnants, and a subdued karst surface may have resulted from the southward retreat of the escarpment.

The basal St. Peter rubble rests on Franconia in some areas. Underground drainage would have been

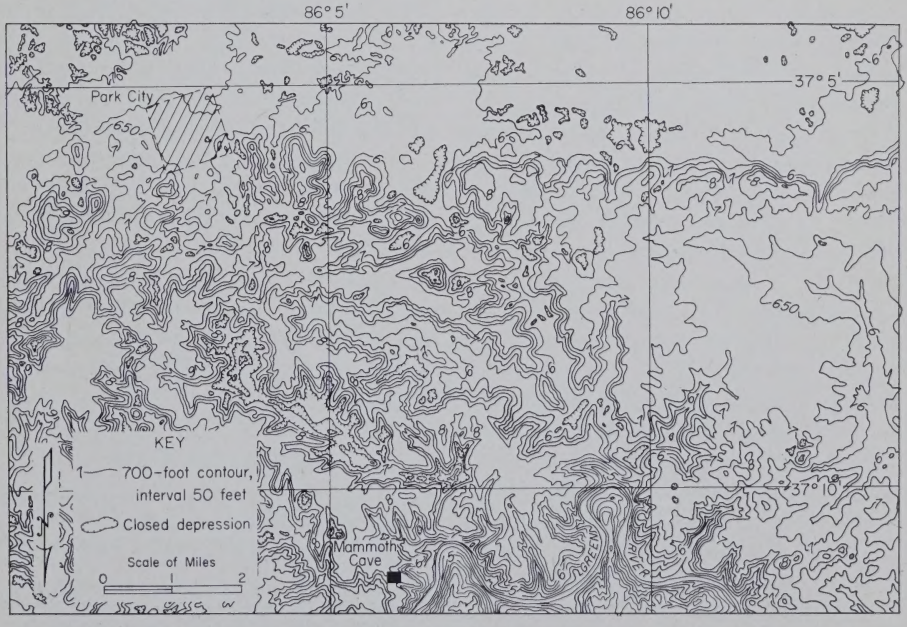

Fig. 5.—Topography of Mammoth Cave region (from U.S.G.S. quadrangle map; alternate 50-foot contours dropped along some steep cliffs).

impeded in a situation where sandstone, siltstone, and shale of the Franconia formed the bedrock surface, and stream erosion would have become increasingly important.

Although the missing carbonates in northern Illinois may have been extensively removed by solution through underground channels, a few deep valleys would favor the process. Examples of major streams which persist in areas of karst development are the Green River in the Mammoth Cave region and the Ohio River in the southern Indiana-northern Kentucky region. Data presently available in northern Illinois do not indicate the specific location of master stream courses, but some of the wells with thick sections of St. Peter Sandstone may penetrate channels rather than sinkholes.

A map of the topography of the sub-St. Peter surface in 150 square miles of northeastern Illinois was constructed from well data (Fig. 3). The top of the Glenwood-St. Peter was assumed to be a horizontal plane, and the elevations on the sub-St. Peter surface were obtained by subtracting the thickness of the Glenwood-St. Peter from the horizontal datum plane. The map shows a portion of the east-west escarpment which can be traced across northeastern Illinois. For comparison with a karst surface, the northeastern Illinois well sites were superimposed on a topographic map of the Mammoth Cave area in Kentucky. Using only the elevations at the projected points, a topographic map of the Mammoth Cave area was sketched (Fig. 4). The maps of the sub-St. Peter surface and the karst surface are similar, although the sub-St. Peter surface has slightly greater relief than the present surface of the Mammoth Cave area. The topographic map of part of the Mammoth Cave quadrangle (Fig. 5) shows vividly that only a meager portion of the sub-St. Peter topography in northeastern Illinois may be revealed by the datum points presently available.

Similar relief on the sub-St. Peter surface is found in other regions. As much as 200 feet has been noted in Iowa (Trowbridge, 1917, p. 178), and as much as 300 feet in Wisconsin and northern Illinois (Thwaites, 1923, p. 541). In eastern Kansas, along the flank of the Southeast Nebraska Arch, Merriam and Atkinson (1956) reported several wells which penetrated abnormally thick Simpson (St. Peter) sediments with chert conglomerate and green shale at the base. They concluded that karst topography was developed on the carbonates of the Arbuckle Group before Simpson deposition.

On the basis of the evidence presently available, it seems warranted to assume that during the hiatus between Canadian (Lower Ordovician) and Champlainian (Middle Ordovician) times, solution played an important part in shaping the sub-St. Peter surface in northeastern Illinois.

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